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MORPHOMETRIC ANALYSIS OF THE MANDIBULAR FORAMEN OF CATS (*Felis catus*, LINNAEUS 1758) WITH NO DEFINED BREED

ANÁLISE MORFOMÉTRICA DO FORAME MANDIBULAR EM GATOS DOMÉSTICOS (*Felis catus*, Linnaeus 1758) SEM RAÇA DEFINIDA

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ABSTRACT: The objective of this work was to perform a morphometric evaluation of the mandibular foramen of cats with no defined breed in order to establish its more precise topography and to offer subsidies for a more effective local anesthetic blockage of the mandibular alveolar nerve. Thirty adult cats (*Felis catus*) (5 male and 25 female) with no defined breed were used. After collection and preparation of mandibles with the aid of a universal caliper rule, the 6 reference points were measured: LONG (from the most lateral margin of the condylar process up to the first inferior incisor tooth); TRANS (from the ventral margin up to the dorsal mandible margin between the second premolar tooth and the first inferior molar tooth); FVENTRAL (from the most rostral margin of the mandibular foramen up to the ventral mandibular margin); ANG (from the end of the most rostral margin of the mandibular foramen up to the mandible angular process), COND (from the end of the most rostral margin of the mandibular foramen up to the medial margin of the mandible condylar process) and COR (from the most rostral margin of the mandibular foramen up to the medial margin of the mandible condylar process). Following, the data obtained were submitted to descriptive statistical analysis and to the student's t-test with $p = 0.05$. It was observed that for a better local anesthetic blockage of the inferior alveolar nerve, the needle should be introduced 4.1 to 4.4 mm from the mandible ventral margin and 12.37 to 12.57 mm from the angular process.

KEYWORDS: *Felis Catus*. Mandibular forame. Morphometry. Analgesia.

INTRODUCTION

The inferior alveolar nerve emerges from the mandibular nerve, which originates the mylohyoid nerve, the inferior caudal alveolar branch, the inferior medial alveolar branch, and the mental foramina, and forms the inferior dental plexus. International Committee on Veterinary Gross Anatomical Nomenclature (1994).

The inferior alveolar nerve is a sensitive nerve and branch of the mandibular nerve that follows ventrally for a distance of approximately 10 mm after its emergence, before penetrating the mandibular foramen. Getty (1986); Regodon (1991); Onar (1999).

The anesthetic blockage performed in the inferior alveolar nerve promotes the anesthesia of the premolar, canine and incisive teeth, skin, cheek mucosa and lower lip. Muir (2001).

Knowing the mandibular foramen location is essential for the local anesthetic blockage of the mandibular and inferior alveolar nerves. Nickel (1981); Blanton e Roda (1995); Milken (2003); Nicholson (1995).

The regional anesthesia emerges in small animals as alternative for analgesia during surgical procedures, enabling a more stable anesthetic period. Groos (1997); Groos (2000). The application of local anesthetic agents before the production of the surgical trauma limits or minimizes the inflammatory tissue reaction and reduces the central sensitivity to pain, providing higher post-surgical comfort. Cediél (1999).

According to Reitz (1998) and Cediél (1999), odontological interventions allow the combinations of drugs, among them the association of tranquilizing and local blockage agents with 2% lidocaine, which promotes immobilization and analgesia.

Odontological procedures in cats such as dental restorations and extraction techniques are common in surgical clinics for small animals and require pre and post-surgical anesthesia. Gioso (2003). The anesthetic agents most commonly used for these dental procedures include opioid, alpha 2-agonistic and non-steroidal anti-inflammatory agents. When parenterally administered, these agents may cause undesirable effects in cats. Gross (2000). The use of most opioids, despite being

excellent analgesic substances, is controlled and when administered without the concomitant use of tranquilizing agents, may promote excitement in cats. On the other hand, non-steroidal anti-inflammatory agents seem to be associated to gastrointestinal lesions in cats. Gross (2000). Thus, regional anesthesia is an adjuvant alternative for systemic drugs for pain control during and after dental procedures in cats.

Local anesthetic agents, when used in adequate doses, cause minimum adverse effects, and besides being non-controlled substances, promote post-surgical analgesia when a long-duration local anesthetic agent is used. Gross (1997).

In humans, the blockage of the inferior alveolar nerve, most commonly (more imprecisely) called as mandibular nervous blockage, is the most employed injection technique and possibly the most important one in dentistry. Unfortunately, it is also the most frustrating and the one presenting the highest percentage of clinical failures (approximately 15 to 20%). Potocnik e Bajrovic (1999); Malamed (2001); Caldeira (2004).

Several authors disagree in relation to the exact location of the mandibular foramen in small animals, and only Gross (2000) specified that the study was conducted in cats. Skarda (1996) and Fantoni e Cortopassi (2002) indicate the position at 5 mm rostrally to the angular process and from 10 to 20 mm dorsally to the margin of the mandible. On the other hand, Muir(2001) report that the process is given at 15 mm rostrally to the angular process and at 15 mm dorsally to the margin of the mandible.

Gross (2000) demonstrated that the location of the mandibular foramen in cats is at 10 mm rostrally to the angular process and at 5 mm dorsally to the margin of the mandible.

The objective of this work is to perform a morphometric evaluation of the mandibular foramen of cats with no defined breed in order to establish its more precise topography and to offer subsidies for a more effective local anesthetic blockage of the mandibular alveolar nerve.

The mandible contains the lower teeth and articulates with the temporal bone. Both mandibles unite rostrally at the intermaxillary suture; however, they do not unite completely even at advanced age. Each mandible may be divided into a body, or horizontal portion and a branch, or perpendicular portion. The alveolar margin of the mandible contains alveolus for the roots of the teeth. Getty (1986); Evans e De Lahunta (1994); International Committee on Veterinary Gross Anatomical Nomenclature (1994); Schaller (1999)

Still according to Evans e De Lahunta (1994) and Boyd (1997), the triangular masseteric fossa is located at the lateral surface of the mandible branch for the insertion of the masseter muscle. The dorsal half of the mandibular branch is the coronoid process. Its medial surface presents a shallow depression for the insertion of the temporal muscle. The mandibular foramen is located ventrally in relation to this depression. This foramen is the caudal opening of the mandibular canal, which is located at the branch and at the mandibular body, and comprises the inferior alveolar vein and artery and the inferior alveolar nerve. It opens rostrally in the mentonian foramens, where the mentonian nerves innervate sensitivity the lower lip and the adjacent chin. The condylar process participates in the formation of the temporomandibular articulation. Among the condylar and coronoid processes, a U-shape depression is found, the called mandibular incision, which is crossed by several motor branches of the mandibular nerve that innervate the masseter muscle. The angular process is a curve salience ventrally to the condylar process and serves for the fixation of the pterygoid muscles medially and masseter muscles laterally.

The mandibular alveolar nerve is a mixed nerve that contributed both with motor and sensitive fibers, and after its origin through the oval foramen, follows ventrally through a distance of 10 mm before penetrating the mandibular foramen. Getty (1986); Evans e De Lahunta (1994).

A local anesthetic agent is considered as any substance that, applied in adequate concentrations, blocks the nervous conduction reversibly. Massone (1999).

Perineural anesthesia has gained special importance in the daily practice due to its convenience and easy application. The techniques are based on the deposition of the anesthetic agent in the perineuron at concentrations ranging according to the surgical time required and on doses that should be sufficient to assure the perineural soaking, what will lead to the nervous impulse blockage. Massone (1999); Fantoni Cortopassi (2002).

Local anesthetic agents have been studied since 1884 with Koller (*apud*, MASSONE (1999), who studied the anesthetic properties of cocaine in the surface of the ocular globe, and in the last century, studies revealed local anesthetic drugs better tolerated by the organism due to their lower toxicity and stronger effect. Massone (1999).

There are several means to produce local anesthesia either transitory or permanent (what is

undesirable) with higher or lower intensity and duration namely:

- Mechanical means (garrote or compression on the nervous sheaf);
- Physical means (cryoanalgesia);
- Chemical means (local anesthetic agents of specific action).

From all means mentioned above, the only one currently employed are local anesthetic agents of specific action, since their action is always safe, reversible and convenient. Fantoni e Cortopassi (2002).

The anesthetic blockage of the inferior alveolar nerve is indicated for procedures to be performed in mandibular teeth such as exodontics indicated for cases of severe periodontal infection and periapical abscesses (with or without fistula), and endodontical procedures, indicated in case of dental fractures, pulpitis or pulp necrosis. Pachaly (1999).

MATERIAL AND METHODS

Thirty adult cats (*Felis catus*) (5 male and 25 female) with no defined breed obtained from the Anatomy Laboratory collection of the Agronomy and Veterinary Medicine School – Federal University of Brasilia (UnB) - were used.

After skin and musculature removal, mandibles were removed through disarticulation of the temporomandibular region. Following, the mandibles were submitted to biological maceration

and later cleared through immersion in 50% hydrogen peroxide solution (Romar Química Farmacêutica, Taguatinga/DF/Brazil).

After this process and with the aid of a caliper rule calibrated in millimeters (universal type, series 125, Starrett, Itu/SP/Brazil), 6 reference points were measured, adopting the following abbreviations: LONG (from the most lateral margin of the condylar process up to the first inferior incisor tooth); TRANS (from the ventral margin up to the dorsal mandible margin between the second premolar tooth and the first inferior molar tooth); FVENTRAL (from the most rostral margin of the mandibular foramen up to the mandible ventral margin); ANG (from the end of the most rostral margin of the mandibular foramen up to the mandible angular process), COND (from the end of the most rostral margin of the mandibular foramen up to the medial margin of the mandible condylar process) and COR (from the most rostral margin of the mandibular foramen up to the medial margin of the mandible condylar process). The data obtained were then submitted to descriptive statistical analysis and to the student's t-test with $p = 0.05$.

Figure 1 demonstrates the mandibular foramen and the position of the mandibular canal through radiographic image.

The reference points are demonstrated in Figures 1 to 3 and the average values were expressed in Appendixes I and II, followed by letter R for right hemimandible and letter L for left hemimandible.



Figure 1. radiographic image showing the medial face of a left hemimandible, demonstrating the topographies of the mandibular foramen and canal of cats with no defined breed (Photo by Prof. Rogério Magno do Vale Barroso in Anatomy Laboratory collection of the Agronomy and Veterinary Medicine School – Federal University of Brasilia (UnB) – 2005).

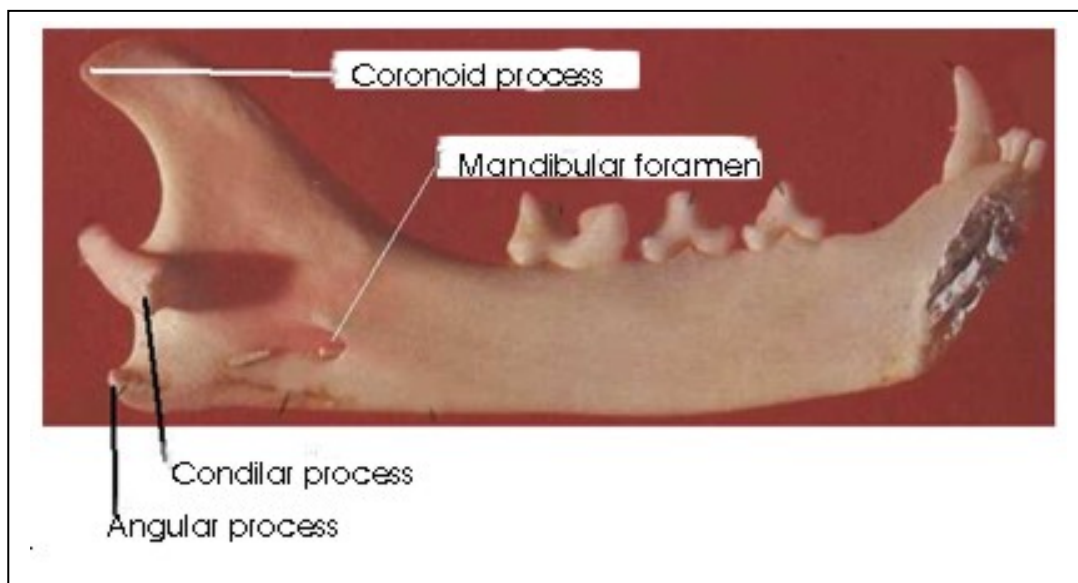


Figure 2. Photograph showing the medial face of a left hemimandible, demonstrating reference points for the morphometric analysis of the mandibular foramen of cats with no defined breed (Photo by Prof. Rogério Magno do Vale Barroso in Anatomy Laboratory collection of the Agronomy and Veterinary Medicine School – Federal University of Brasília (UnB) – 2005)

- 1 – Longitudinal distance from the mandible (LONG) - White;
- 2 – Transversal distance from the mandible (TRANS) - Yellow;
- 3 – Distance from the mandibular foramen to the mandible ventral margin (FVENTRAL) - Blue;
- 4 – Distance from the mandibular foramen to the mandible angular process (ANG) - Lilac;
- 5 – Distance from the mandibular foramen to the mandible condylar process (COND) - Red;
- 6 – Distance from the mandibular foramen to the mandible coronoid process (COR) - Green.

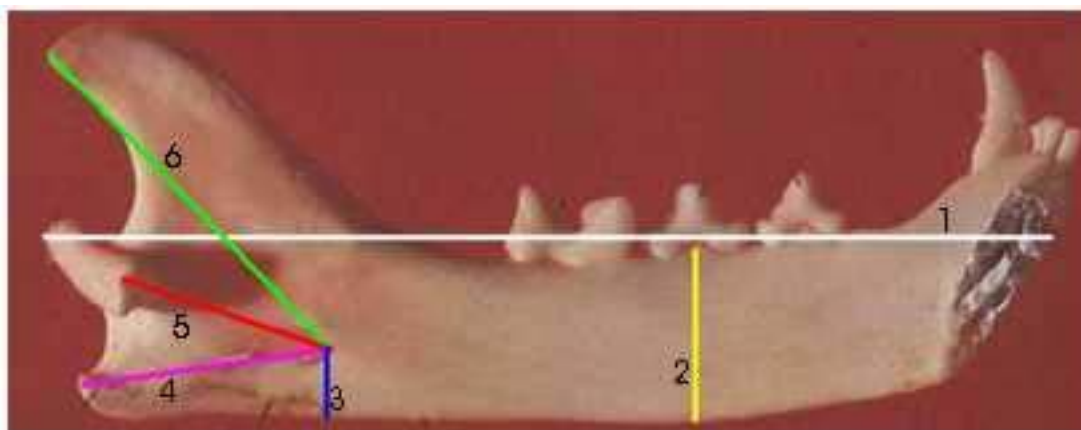


Figure 3. Photograph showing the medial face of a left hemimandible, demonstrating the distances measured for the morphometric analysis of the mandibular foramen of cats with no defined breed (Photo by Prof. Rogério Magno do Vale Barroso in Anatomy Laboratory collection of the Agronomy and Veterinary Medicine School – Federal University of Brasília (UnB) – 2005).

RESULTS

As demonstrated in Table 1 and considering the descriptive statistical analysis and the student's t-test with $p = 0.05$ and confidence interval of 95%,

this study found average of 51.47 mm with standard deviation of 4.015 mm for right LONG variable and average of 51.83 mm with standard deviation of

5.004 mm for left LONG variable and the comparison between antimers, $p = 0.291$ (Curve I) demonstrated no significant difference.

Table 1. Morphometric measures (mm, average \pm standard deviation) of the mandibular foramen of cats with no defined breed. It measured gotten of 30 animals (5 males and 25 females).

Measured Point	Right hemimandible Average \pm Standard deviation	Left hemimandible Average \pm Standard deviation
LONG	51.47 \pm 4.015	51.83 \pm 5.004
TRANS	8.6 \pm 1.070	8.5 \pm 1.042
FVENTRAL	4.17 \pm 1.206	4.4 \pm 1.329
COND	21.93 \pm 1.982	22.07 \pm 2.083
COR	11.00 \pm 1.722	11.27 \pm 1.660
ANG	12.37 \pm 1.474	12.57 \pm 1.547

Estatistical analysis from laboratory of bioestatistical – Federal University of Uberlandia - 2005

For right TRANS variable, this study found average of 8.6 mm with standard deviation of 1.070 mm and for left TRANS variable, average of 8.5 mm with standard deviation of 1.042 mm. In the comparison between antimers, the result of $p = 0.264$ (Figure 4) demonstrated no significant difference.

Analyzing the right FVENTRAL variable, the average found was 4.17 mm with standard deviation of 1.206 mm, and for left FVENTRAL variable, the average was 4.4 mm with standard deviation of 1.329 mm; the student's t-test applied between antimers revealed result of $p = 0.09$ (Figure 4), demonstrating no significant difference.

Considering the right ANG variable, the average found was 12.37 mm with standard deviation of 1.474 mm and for the left ANG

variable, the average found was 12.57 mm with standard deviation of 1.547 mm. In the comparison between both right and left antimers through the student's t-test, the result was of 0.031 (Figure 4) indicating therefore, significant difference.

For the COND variable, averages and standard deviations were 21.93 \pm 1.982 mm for the right hemimandible and 22.07 \pm 2.083 mm for the left hemimandible. The student's t-test revealed result of 0.403 (Figure 4), and no significant difference between antimers.

The COR variable also showed significant difference between antimers, with $p = 0.003$ (Figure 4) and with averages and standard deviations of 11.00 \pm 1.722 mm for the right hemimandible and 11.27 \pm 1.660 mm for the left hemimandible.

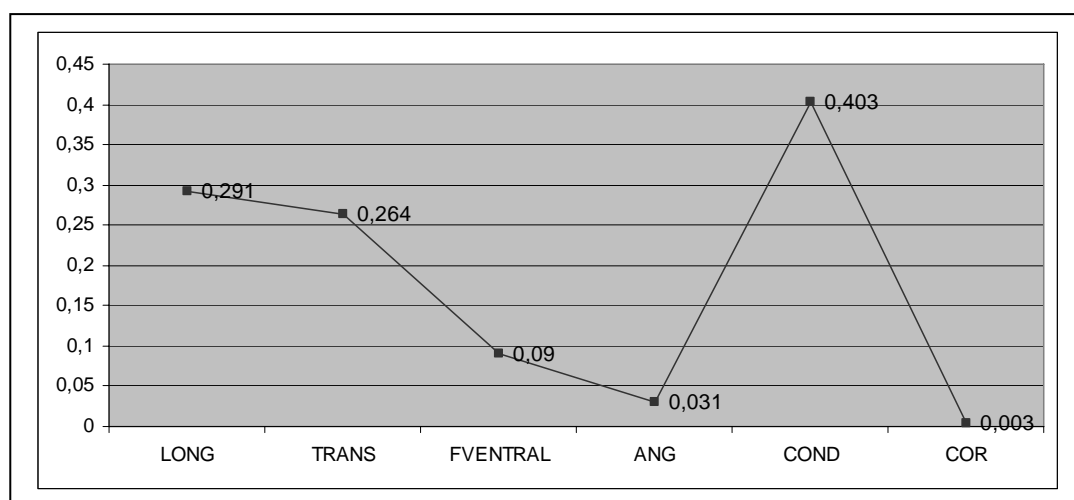


Figure 4. Comparison between right and left hemimandibles through the student's t-test with $p = 0.05$ of cats with no defined breed.

DISCUSSION

As described by Getty (1986); Evans e De Lahunta (1994); Boyd (1987) and König e Liebich (2004), this study also found the mandibular branch with its medial surface presenting a shallow depression for the insertion of the temporal muscle, ventrally positioned, and the mandibular foramen, which is the opening of the mandibular canal, was located.

Nicholson (1995), Blanton e Roda (1995); Afsar (1998) and Potocnik e Bajrovic (1999) report differences in the position of the mandibular foramen in humans, what was not verified in this study with cats, where significant differences in angular and coronoid processes were also found between mandibular antimers.

The morphometric analysis of the mandibular foramen both of dogs and cats is not described in the anatomical literature, and only data referring to anesthesia can be found. However, Groos (2000) described this analysis in cats but did not compare the antimers.

Groos (2000) and Milken (2003) demonstrate that the location of the mandibular foramen is at 10 mm rostrally to the angular process and at 5 mm dorsally to the mandible ventral margin.

Muir (2001) propose the introduction of the needle at 15 mm rostrally to the angular process and 15 mm dorsally to the mandible ventral margin in order to obtain a successful local anesthetic procedure of the inferior alveolar nerve.

On the other hand, Skarda (1996) and Fantoni e Cortopassi (2002) propose the

introduction of the needle at 5 mm rostrally to the angular process and from 10 to 20 mm dorsally to the mandible ventral margin.

Considering both variables adopted by the authors previously mentioned, this study found a distance between 4.1 and 4.4 mm from the mandibular foramen to the mandible ventral margin as result with no significant difference between antimers and 12.37 mm from the angular process to the mandibular foramen for the right mandible and 12.57 for the left mandible, with the presence of significant differences between antimers. Groos (2000) and Milken (2003) were the authors who obtained results most similar to those found in the present study.

Therefore, when performing the anesthetic blockage of the inferior alveolar nerve, one should take the antimer to be anesthetized into consideration in order to obtain a better result.

CONCLUSIONS

A significant variability in the position of the mandibular foramen between antimers of cats was observed, when COND and COR variables were considered. The other variables did not present significant differences, mainly FVENTRAL and ANG, which are the points clinically adopted for localization during local anesthesia process.

For a better local anesthetic blockage of the mandibular alveolar nerve of cats, the needle should be introduced 4.1 to 4.4 mm from the mandible ventral margin and 12.37 to 12.57 mm from the angular process.

RESUMO: Objetivou-se, avaliar morfometricamente o forame mandibular, em gatos sem raça definida, visando ainda estabelecer de forma mais precisa sua topografia, com vistas a oferecer subsídios para um bloqueio anestésico local mais efetivo do nervo alveolar mandibular. Foram utilizados 30 gatos domésticos (*Felis catus*) adultos, 5 machos e 25 fêmeas, sem raça definida. Após a coleta e o preparo das mandíbulas, com auxílio de um paquímetro milimetrado tipo universal, foram mensurados 6 pontos de referência, LONG (da borda mais lateral do processo condilar até o primeiro dente incisivo inferior); TRANS (da borda ventral até a borda dorsal da mandíbula entre o segundo dente pré-molar e o primeiro dente molar inferiores); FVENTRAL (da borda mais rostral do forame mandibular até a borda ventral da mandíbula); ANG (da extremidade da borda mais rostral do forame mandibular até o processo angular da mandíbula); COND (extremidade da borda mais rostral do forame mandibular até a borda medial do processo condilar da mandíbula) e COR (da borda mais rostral do forame mandibular até a borda medial do processo condilar da mandíbula). Em seguida os dados obtidos foram submetidos à análise estatística descritiva e ainda aplicou-se o teste T de Student com $p=0,05$ onde observou-se que para um melhor bloqueio anestésico local do nervo alveolar inferior a agulha deverá ser introduzida de 4,1 a 4,4 mm da borda ventral da mandíbula e entre 12,37 a 12,57 mm partindo do processo angular.

PALAVRAS-CHAVE: *Felis Catus*. Forame mandibular. Morfometria, analgesia.

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